

JUL 30 2007

Docket No. 843.43729X00
Serial No. 10/811,973
Office Action dated April 30, 2007

REMARKS

I. Introduction

By the present Amendment, claim 1 has been amended. Claims 2-6, 11, and 21 have been cancelled. Accordingly, claims 1, 9, 12-16, 19, and 20 remain pending in the application. Claim 1 is independent.

II. Interview

Applicants would like to thank Examiners Sandvik and Purvis for the courtesy and cooperation extended during the Interview conducted on July 23, 2007. During the Interview, proposed amendments to independent claim 1 were discussed with respect to the art of record. The class definitions in the JIS H4541 standard were also discussed with respect to being combined with the Ochi reference. It was agreed that the proposed amendments distinguished the claimed invention from the combination of references with respect to the ratio of copper in the first and second electrodes.

III. Office Action Summary

In the Office Action of April 30, 2007, claim 1 was objected to because of an informality. Claims 1, 2, 11-13, and 16 were rejected under 35 USC §103(a) as being unpatentable over U.S. Patent No. 6,344,790 issued to Ochi et al. ("Ochi"), in view of U.S. Patent No. 5,532,434 issued to Takeno et al. ("Takeno"). Claims 3, 9, 14, and 15 were rejected under 35 USC § 103(a) as being unpatentable over Ochi in view of U.S. Patent No. 4,042,951 issued to Robinson et al. ("Robinson"). Claims 5 and 21 were rejected under 35 USC §103(a) as being unpatentable over Ochi in view of Robinson, and further in view of U.S. Patent No. 3,723,835 issued to Davis

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("Davis"). Claim 6 was rejected under 35 USC §103(a) as being unpatentable over Ochi in view of Davis. Claims 4, 19, and 20 were rejected under 35 USC §103(a) as being unpatentable over Ochi in view of U.S. Patent No. 4,742,377 issued to Einthoven. These rejections are respectfully traversed.

IV. Objections to the Claims

Claim 1 was objected to because of an informality. Regarding this objection, the Office Action cites an instance of what appears to be either a grammatical or typographical error.

By the present Amendment, Applicants have amended independent claim 1, in part, to address the informality noted in the Office Action.

V. Rejections under 35 USC §103

Claims 1, 2, 10-13, and 16 were rejected under 35 USC §103(a) as being unpatentable over Ochi in view of Takeno. Regarding this rejection, the Office Action alleges that Ochi discloses a device that includes first and second electrodes having layers containing copper as the main components, a semiconductor element arranged between the two electrodes and electrically connected to the first and second electrodes, as well as a glass ceiling member which seals the first electrode, the semiconductor element and the second electrode. The Office Action indicates that the first and second electrodes include ratios of the layers containing copper as the main components that are not less than 20 wt% and equal to or less than 25 wt%. Furthermore, the first and second electrodes are indicated as having copper oxide layers formed on the outer peripheries of the layers containing copper as the main components. The Office Action admits that Ochi fails to disclose the thickness of the

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copper oxide layers being 1.5 μm or less. Takeno is relied upon for disclosing a copper wire that has a copper oxide layer of 0.1 μm .

By the present Amendment, Applicants have amended independent claim 1 to better define the claimed invention and clarify features that are not shown or suggested by the art of record. The subject matter previously recited in claims 2, 4, 5, 6, and 11 has also been incorporated therein. As amended, independent claim 1 now defines a semiconductor device that comprises:

first and second electrodes having layers containing copper as main components;

a semiconductor element arranged between said first and second electrodes and electrically connected to said first and second electrodes; and

a glass sealing member which seals said first electrode, said semiconductor element, and said second electrode,

wherein:

the semiconductor element includes a metal electrode,

the semiconductor element is a Schottky barrier diode,

the first and second electrodes are constituted by Dumet wires,

ratios of the layers in the first and second electrodes containing copper as main components fall within the range of 21 to 24 wt%,

said first and second electrodes have copper oxide layers formed on the outer peripheries of said layers containing copper as main components, the copper oxide layers contacting with said glass sealing member,

the thickness of said copper oxide layers is 1.5 μm or less at the time before said first and second electrodes are glass-sealed,

a sealing temperature of said glass sealing member is 630°C or less and is a temperature at which silicification of said metal electrode of the semiconductor element is not enhanced, and

a glass softening point of said glass sealing member is 560°C or less.

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The semiconductor device of independent claim 1 includes first and second electrodes that have layers containing copper as the main components. A semiconductor element is arranged between the first and second electrodes and electrically connected to the first and second electrodes. A glass sealing member is provided to seal the first electrode, the semiconductor element, and the second electrode. Further, the semiconductor element is a Schottky barrier diode and includes a metal electrode. The first and second electrodes are also constituted by Dumet wires. Ratios of the layers in the first and second electrodes containing copper as the main components fall within the range of 21 to 24 wt%. The first and second electrodes have copper oxide layers formed on the outer peripheries of the layers containing copper as main components and the copper oxide layers contacting with the glass sealing member, and the thickness of the copper oxide layers is 1.5 μm or less at the time before the first and second electrodes are glass sealed. Furthermore, a sealing temperature of said glass sealing member is 630°C or less and is a temperature at which silicification of said metal electrode of the semiconductor element is not enhanced, and a glass softening point of said glass sealing member is 560°C or less.

According to the arrangement of independent claim 1, the glass sealing member has a low melting point and the sealing temperature is reduced, thereby suppressing silicification of in the Schottky junction as well as leakage current. Furthermore, the adhesive properties between the Dumet wires and the glass sealing members can be improved because the ratios of layers containing copper are maintained within 21-24 wt%.

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As discussed during the Interview, the cited references do not provide disclosure or suggestion for all the features recited in independent claim 1. Ochi provides a structure wherein a temperature sensitive resistor is sealed in a glass sealing member. The device of Ochi is configured such that the temperature sensitive resistor, or thermistor, is sealed within the glass sealing member and the Dumet wires sandwich and contact the thermistor from both sides. See Fig. 4, column 3, lines 26-33. Ochi provides a Dumet wire that contacts a core wire made of an iron-nickel alloy coated by an intermediate layer form of copper. The intermediate layer is further covered by a layer of copper oxide. As further noted in the Office Action, Ochi is completely silent on the thickness of the copper oxide layers. Applicants further note that, as amended, independent claim 1 now requires the ratio of copper content fall within the range of 21-24 wt%.

While JIS H4541 discloses various values for percentage of copper to be used in different classes of Dumet wires, the combination with Ochi does not lead to the claimed invention. Table 1 sets forth the definition for different classes of Dumet wires. Only "Class 2" is relevant to the present invention because it relates to semiconductor devices such as diodes and thermistors. Ochi specifically refers to JIS H4541 with respect to a sealed glass thermistor at column 1, lines 26-29. Ochi must necessarily be referring to Dumet wire class 2 when discussing JIS H4541. Accordingly, the appropriate recommendation from JIS H4541 must be for 13% – 20% copper content. In contrast, independent claim 1 recites both a Schottky barrier diode and a copper content of 21 – 24 %.

Additionally, it appears that Ochi and Takeno are not properly combined to reject the claims. Ochi and Takeno are in entirely different fields of endeavor. Ochi discloses an electronic device that includes a thermistor sealed within a glass

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sealing member. Takeno discloses a wire including an insulation that can be easily peeled by means of a laser. Additionally, the teachings of Takeno were clearly available to Ochi at the time of filing his application. Nonetheless, Ochi himself was not motivated to seek out the teachings of Takeno to modify his invention for purposes of improvements as alleged in the Office Action. The combination of applied references simply fails to provide disclosure or suggestion for all the combination of features recited in independent claim 1. In particular, Applicants note the failure by the references to provide features such as:

wherein:

- the semiconductor element includes a metal electrode,
- the semiconductor element is a Schottky barrier diode,
- the first and second electrodes are constituted by Dumet wires,
- ratios of the layers in the first and second electrodes containing copper as main components fall within the range of 21 to 24 wt%,

It is therefore respectfully submitted that independent claim 1 is allowable over the art of record.

Claims 2-6, 9, 11-16, and 19-21 depend, either directly or indirectly, from independent claim 1, and are therefore believed allowable for at least the reasons set forth above with respect to independent claim 1. In addition, these claims each introduce novel elements that independently render them patentable over the art of record.

The Office Action also combines Ochi with various other references to sustain rejection of some of the dependent claims. Applicants note, however, that none of the secondary references remedies the failure by Ochi to disclose features recited in the claimed invention.

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VI. Conclusion

For the reasons stated above, it is respectfully submitted that all of the pending claims are now in condition for allowance. Therefore, the issuance of a Notice of Allowance is believed in order, and courteously solicited.

If the Examiner believes that there are any matters which can be resolved by way of either a personal or telephone interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

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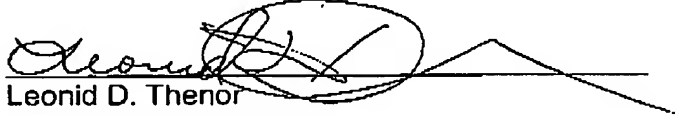
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AUTHORIZATION

Applicants request any shortage or excess in fees in connection with the filing of this paper, including extension of time fees, and for which no other form of payment is offered, be charged or credited to Deposit Account No. 01-2135 (Case: 843.43729X00).

Respectfully submitted,

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